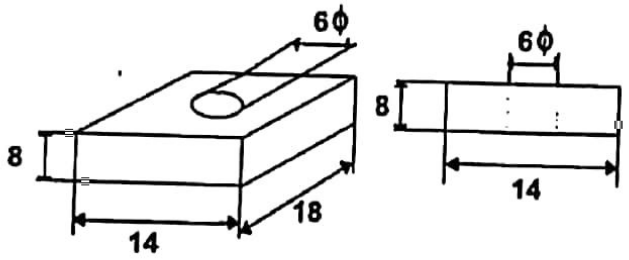
INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR
TIME: 2HRS, FULL MARKS: 100, DEPT.: MECHANICAL ENGINEERING
MID AUTUMN SEMESTER EXAMINATION: Sept-2019
No of students: 181
SUB NO: **ME31007**, SUB NAME: **CASTING, FORMING AND WELDING**

Instructions:

- **Assume any data, if required BUT NOT mentioned in the question. Clearly mention your assumption.**
- **Answer Casting, Forming & Welding parts separately in SAME answer sheet.**

	Part A Casting (33 marks)	
C1	(a) What are the materials used for making pattern and how do you select them? (b) The casting shown is to be made of Aluminum using a wooden pattern. Assuming only shrinkage allowance, calculate the dimension of the pattern up to 2 decimal points. Shrinkage allowance of Aluminum is **0.155 inch/ft**. All dimensions are in **inches**. 	3+4 =7
C2	(a) Define the following properties of sand. (i) Refractoriness, (ii) Green strength, (iii) Hot strength and (iv) Cohesiveness (b) Draw solidification curve w.r.t time (i.e. cooling curve) of a pure metal and alloy. Also, show both the local and total solidification time on the curve.	4+4 =8
C3	Why is dendrite microstructure developed in metal casting (answer briefly to the point)? What is center line feeding resistance?	5+3 =8
C4	(a) What is critical radius r* during the solidification process? Briefly explain with a schematic diagram. (b) A **100 mm** thick square plate sample has equal volume that of a cylindrical metal sample of radius of **100 mm** and height of **25 mm**. These two samples are fabricated by sand casting process under similar moulding condition. Also, cylindrical top risers are used to avoid shrinkage cavities during sand casting of both the above samples. Explain (briefly and to the point) whether both the above samples require risers of same dimensions (i.e. radius and height).	5+5 =10

	Part B Forming (34 marks)	
F1	Estimate the packing efficiency of a HCP crystal structure.	4
F2	Write short notes on the following (brief and to the point) (a) Eutectoid reaction in iron and iron-carbide equilibrium phase diagram (b) Flame hardening of steel (c) Strain hardening (d) Bauschinger effect	2x4 =8

F3	A tensile specimen of mild steel sheet of **2.0 mm** thickness, **50 mm** gauge length and **6 mm** width is subjected to uniaxial tensile loading before the onset of necking. Due to this, the gauge length is elongated to **60 mm** through the above plastic deformation; and the plastic strain is uniformly distributed over the entire tensile sample. The sheet metal is ***isotropic***. Estimate the change in thickness of this isotropic sheet metal due to the above elongation. (Note- Neglect the elastic deformation).	4
F4	(a) Draw both the von-Mises and Tresca yield loci in 2-D stress space (i.e. in principal stress space under plane stress condition) superimposing both the loci. (b) A metal body is under plastic deformation state having stress state given by principal stresses of **100, -150 and 200 MPa**. Determine the yield strength of this above metal under pure shear as per von-Mises yield theory.	5+4 =9
F5	(a) Define neutral plane during rolling process. (b) Draw a neat schematic diagram of a four-stand tandem cold-rolling mill. (c) A **4.0 mm** thick mild steel sheet is rolled with a **400 mm** diameter steel rolls to reduce the thickness under plane strain condition, and without application of any tension at the ends. The friction coefficient at the sheet-roll interface is **0.1**, and both the rollers are rotating constantly at **1000 RPM**. Also, the ***rolls are rigid without any elastic deflection*** during the rolling process. The yield strength of the steel material as per Tresca yield criterion is **300 MPa**. What is the minimum possible thickness of the sheet that can be produced in a single pass?	2+3 +4= 9

Part C Welding (33 marks)		
W1	What are the different types of arc in arc welding, explain? Schematically illustrate high and low temperature plasma. Would a Helium plasma produce a hotter or a colder arc than Argon plasma? Why? What are the factors that lower the arc/plasma temperature?	4+2+1 +1+2 = 10
W2	Explain the V-I (voltage-current) characteristics of an arc and the influence of arc length on the potential barrier.	4+3=7
W3	The power source in a welding set up generates **5kW** that can be transferred to the work surface with a heat transfer factor **f1=50%**. The metal to be melted is titanium (not titanium alloy) whose melting temperature is **1923K**. The melting factor in the operation is **0.10**. A continuous fillet weld is to be made with cross sectional area of **10 mm^2**. Assume the following data in relation to titanium; Heat capacity of titanium (C_p) = **545 J/kg-K**; Latent heat of melting (L_m)= **400 kJ/kg**; Density of titanium (ρ) =**4500 kg/m^3**; Initial work surface temperature (T_0)= **300K**. Determine a) Rate of heat input into the weld bead, b) The travel speed at which welding operation can be accomplished.	3+5=8
W4	Illustrate grain growth in fusion welding. What is the role of flux in arc welding process and how is it delivered to the work surface?	4+2+2 =8

Best wishes to the students from all the course instructors